Product Passport through Twinning of Circular Value Chains

Deliverable 1.3

Sustainability Balanced Scorecard Framework v1

WP1: Digital Circular Value Chain Framework

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Executive Summary

This deliverable provides the first version of the Sustainability Balanced Scorecard Framework of the Plooto project. It describes which KPIs will be taken into consideration for the Plooto Balanced Scorecard, and the process of selection and interoperability of these indicators.

The presented KPIs will be taken into account by the pilot partners of the Plooto project, that will decide which ones are more suitable for their own industrial domain. The responsible partners will then collect and analyse the data, feeding the results to the Balanced Scorecard.

For clarity and usability, the KPIs are divided in four main categories: Environmental, Social, Governance, Economic and Growth.

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Acronyms and Abbreviations

Acronym	Description
CFRP	Carbon Fiber Reinforced Plastics
COD	Chemical Oxygen Demand
CPW	Citrus Processing Waste
CPWW	Citrus Peels Wastewater
DoA	Description of Action
DOC	Depends on the Case
DPP	Digital Product Passport
DT	Digital Twin
EC	European Commission
ERT	European Round Table
ESG	Environmental Social Governance
GHG	Greenhouse Gas
GRI	Global Reporting Initiative
KPI	Key Performance Indicator
POV	Proof of Value
SBSC	Sustainability Balanced Scorecard
WEEE	Waste Electrical and Electronic Equipment

1 Introduction

1.1 Purpose and Scope

The purpose of this Report is to give an overview of the Plooto Sustainability Balanced Scorecard (SBSC) Framework, implemented in the Plooto project. Towards this direction, this document will introduce the background of this specific framework, the reference frameworks and architectures and the necessities of the use cases that this scheme will tackle. Finally, this document will describe the Plooto SBSC Framework, its architecture and the selected KPIs for its scope. This is the first version of this deliverable.

1.2 Relation with other deliverables

This Report will be updated and expanded in D1.4 "Sustainability balanced scorecard framework v2" in Month 24. This document is closely linked to Deliverable D3.5 "Plooto Balanced Scorecard v1" due in Month 18 of the project.

1.3 Structure of the document

The document is structured as follows:

- **Section 2** introduces the Governance Framework, formed by Sustainability and Data Governance frameworks.
- **Section 3** describes the overall structure of the Sustainability Framework, its mission, and its relation to the other tasks and reference frameworks.
- **Section 4** describes in detail the identified KPIs, the models that are foreseen for this framework and the potential scalability.

2 The Governance Framework

Plooto Governance Framework is structured around three main pillars:

The business/collaboration framework: this provides the business and operational aspects of the circular supply chains. Mainly, it contains the following:

- The description of the waste value chain along with the definition of the stakeholders, their inputs and outputs.
- The description of the materials/products flow, along with the necessary conditions for materials transformation.
- The description of the Information sharing principles, such as which information is being shared, how information is generated inside the organization and how information is populated in the supply chain.

The work performed for this part of the Governance Framework is reported in deliverable: D1.1: Plooto methodological approach and business cases specifications version 1.

The data governance framework: this provides the data ownership principles in line with the International Data Spaces Association principles and specifications. A detailed description is given in Section 2.1 of this document.

AI models governance framework: this provides the necessary AI models or services liability issues with regards to the ownership of the algorithms, the explainability principles and how users can be engaged in the decision-making process. A detailed description is given in Section 2.2 of this document.

2.1 Data governance

Data governance is about liability on the data to be produced, processed and shared. This means that supply chains should encompass a data sharing policy on which ownership and data access is specified. This becomes more critical since Plooto deals not only with monitoring of supply chains but also with the concept of Digital Product Passport (DPP).

Based on the collaboration agreements (business collaboration framework) each stakeholder will be responsible to generate the data and make it available to the receipt parties to incorporate it. In the case of DPP we will follow an incremental and aggregation approach in supply chains. This means that alongside the supply chain, every material/product that is being shared has a DPP that will be sent to the next actor in the network (supply chain). The DPP needs to contain **at least** the information agreed for the production of the final product DPP. This aggregation process is described in Figure 1.

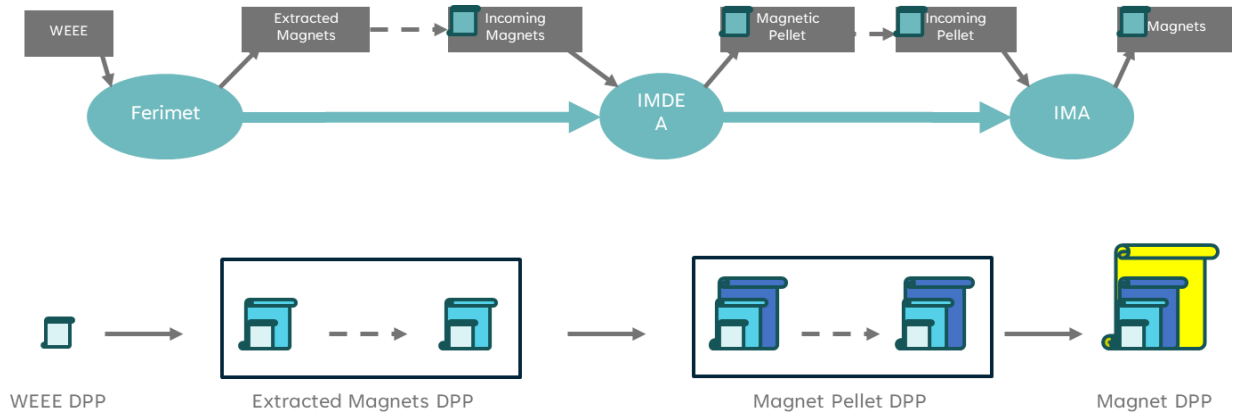

Figure 1: Digital Product Passport aggregation

From a technical perspective, data governance will be implemented following the IDS specifications. Additionally, Plooto will offer a new functionality of integrating the IDS connector and data sharing principles into a monitoring interface. On this interface, stakeholder will have a complete view of the materials and products' Digital Twins shared within the network. It will also provide tools to monitor access control policies and data-sharing rules defined in the IDS connector. The architecture and technical specifications are analytically described in the CRIS requirements and specifications deliverables (D1.5 and D1.6).

2.2 AI models governance

AI models' governance deals with the principles of liability, explainability and fair operation of the AI models that are embedded in the various services supporting the circular value chains.

Given the fact that value chains can operate different AI-based services, we can consider that the service provider will have to ensure that the model has the necessary mechanisms for explainability and treatment of the data in FAIR (Findable, Accessible, Interoperable, Reusable) principles.

We will consider a generic layer for AI services operating under value chains. This layer will adopt a user-centric approach in terms of explainability. Besides presenting results in a clear manner, it will provide specific information that informs the end user about how the result was produced and under which conditions.

In line with this principle, for each provided AI service, Plooto will deliver the necessary functionality to create the statement of models' usage and conditions. In the Plooto project we will specify and deliver a functionality where every service provider (together with the registration of the service into Plooto), will produce a contextual, explainable form (statement) describing how results were obtained. More specifically, this will be a configurable form filled by each AI service provider, including:

- Information on the model statement

- Questions and things to be asked by the AI service (modelled per case). This will create a set of feedback questions to the end users about things the model needs to learn or improve.
- Feedback actionable steps from the end users (during the model execution and/or at the end).

The main usage scenario for such model statement will be:

Upload model statement (from service provider)

The service provider creates an AI statement with the following:

- Versioning
- Model Statement
- Function for user feedback

Model execution and user feedback

Users will be able to interact with the service and provide feedback when possible, during and after the model execution.

The basic elements of the model statement (supplied by the model provider) will be:

- **Maintenance and history**: versioning of the statement and history of updates.
- **Model structure**: provides all information how the model works (basic functionality, flows, inputs, processing and outputs).
- **Data Structure**: any information about the data that the model is trained or updated/evolving.
- **Evaluation info**: any relevant information of how the model has been evaluated and verified along with specific criteria related to basic KPIs such as robustness, performance, etc.
- **Usage requirements**: how the model can be used by the end users.
- **Compliance declaration**: statements of compliance with applicable norms/legislation, EU AI Act, etc.

The model statement will act also like the DPP. It will be incorporated in every message or information shared in the supply chain (where such information is generated using any AI-based service).

3 The Sustainability Framework

3.1 Reference Frameworks

As nations, organizations, and individuals experience the effects of unsustainable operations every one of them is expected to act responsibly. 2018 was the first year that large public-interest entities employing over 500 persons, were obligated to annually report the "double materiality"[1] regarding sustainability issues, more commonly, to report on Environmental, Social and Governance (ESG) issues. Later, on April 21st of 2021, the European Commission (EC) adopted the sustainable finance package, revising the Non-Financial Reporting Directive 2014/95/EU, aiming to build an economy that works for people, decoupling the economic growth from resource use and ensure the socially just transition to a sustainable economic system.[2] This undertaking targeted to eliminate the risk that sustainability issues present for companies and vice-versa, the impact of companies on the people and the environment. To assess the performance of this interaction, available relevant information and a common reported framework were necessary, therefore, the ESG framework became one of the critical cornerstones for companies' performance assessment. The increase of scope deployed through the amendment of 2021 implies that over 50.000 companies across EU have to report on ESG issues from 2023 onwards.

According to Deloitte, the environmental pillar presents the greatest level of complexity during reporting, since it requires the measurement and management of emissions (GHGs and industry-related), resources (energy, water, virgin materials, land use and other) and waste, also the potential positive sustainability impacts, which may represent the long-term business advantages.[3]

Up today, there is no standardized reporting process on ESG, since no official framework or standards have been proposed. The companies assess the sustainability reporting standards to define the process, the data and the objectives of the reporting, applying one or more available frameworks. Within the scope of Plooto project, extensive research was carried out aiming to define an all-inclusive, comprehensive framework, capitalizing on the available information and work that has been done until today on this.

In this section the frameworks, tools and standards that the Plooto consortium considered before devising the Plooto sustainability framework are presented. Upon these, is based the respective sustainability scorecard for assessing the sustainability and circularity of processes and products, along the various steps of their life in a value chain. The full analysis of Sustainability Standards and Framework is presented in Annex 1.

[1] What is ESG? Available at: #1 What is ESG? (deloitte.com)
[2] Proposal for a Directive of the European Parliament and the Council amending Directive 2013/34/EU, Directive 2004/109/EC, Directive 2006/43/EC and Regulation (EU) No 537/2014, as regards corporate sustainability reporting, source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0189
[3] https://www2.deloitte.com/ce/en/pages/global-business-services/articles/esg-explained-1-what-is-esg.html

3.1.1 ESG - Environment, Society & Governance (framework)

ESG is a non-financial framework for organizations to disclose their performance in line with a series of standards related to their **Environmental** impact, their **Social** responsibility and their **corporate Governance**. Its intent is to help organizations measure their performance across those three aspects so that they can better manage their impact and as a result: improve it. Public reporting of the results is enhancing transparency and therefore increases the sense of responsibility for the organization. It is also enabling better regulatory control and raises awareness among individuals. Table 1 depicts the areas tackled by ESG. The ways to measure the performance are continuously getting more structured and standardized and this is perhaps the biggest advantage and disadvantage of this framework at the same time. On the one hand the flexibility of non-standardized measures makes them easily adaptable to the activities of any company. On the other hand, this flexibility can lead to greenwashing since it allows companies to self-determine what and how to measure and report their performance.

Table 1 - ESG overview

ESG areas of performance measuring		
Environmental impact	**Social responsibility**	**Governance**
• Climate change • Natural resource use • Energy use • Pollution and waste • General environmental performance • Biodiversity • Product, packaging, material impacts	• Workers' health and safety • Ethical employment conditions • Product liability • Volunteering and community investment • Gender and diversity • Human rights	• Corporate transparency • Conflicts of interest • Corruption and tax avoidance • Business ethics • Regulatory compliance • Lobbying

3.1.2 GRI – Global Reporting Initiative (standards)

Often going hand-in-hand with ESG, Global Reporting Initiative (GRI) provides a wide range of well recognized and widely used standards to measure and report on ESG[4]. They are divided in three categories: Universal, Sector and Topic standards. Organizations deciding to report following the GRI can pick their sector and the topics they want to focus on as per their ESG priorities but are obliged to report on all universal standards for consistency. Individuals can get certified as professionals to conduct reporting based on GRI but a GRI report is not required to be prepared by certified professionals only allowing here as well for flexibility but also mistakes.

3.1.3 IFRS – International Financial Reporting Standards

IFRS Accounting Standard and Sustainability Disclosure Standard are developed using the same due process and are designed to meet investor information needs and enable companies to communicate decision-useful information efficiently to global capital markets[5]. They include standards that apply to all sustainability-related risks and opportunities including illustrative

[4] GRI Standards: https://www.globalreporting.org/standards
[5] IFRS Knowledge hub: https://www.ifrs.org/sustainability/knowledge-hub

guidance for industry-specific, and climate related metrics. They require disclosure of material information as well as industry-specific disclosures. The IFRS Foundation's International Accounting Standards Board (IASB) and International Sustainability Standards Board (ISSB) are jointly responsible for the **Integrated Reporting Framework**[6], used to connect financial statements and sustainability-related financial disclosures.

3.1.4 TCFD & TNFD – Taskforces on Climate and Nature-related Financial Disclosures (framework)

TCFD and TNFD are referring to a risk management and disclosure framework[7] for companies to identify, assess, respond to and, disclose their climate- and nature-related issues created by a **market-led, science-based and government-supported global initiative. The framework draws from and feeds into relevant standards, including those of the IFRS (and its sister committee ISSB), the GRI, the EFRAG**[8] **and others.** Its recommendations are designed to provide decision-useful information to capital providers and other stakeholders, while helping organisations identify and assess their climate- and nature-related issues. It is directly linked to the EU Corporate Sustainability Reporting Directive (CSRD)[9].

3.1.5 SDGs - Sustainable Development Goals (framework)

The 2030 Agenda for Sustainable Development, adopted by all the United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (Figure 2), which are an urgent call for action by all countries - developed and developing - in a global partnership with not only governments but also organizations, businesses and individuals. They are intertwined with the ESG framework and with measurements standards, including multiple KPIs to track the progress in each goal.

[6] Integrated Reporting Framework: https://www.integratedreporting.org
[7] Guidance on the identification and assessment of nature-related issues: the LEAP approach: https://tnfd.global/publication/additional-guidance-on-assessment-of-nature-related-issues-the-leap-approach
[8] Who is EFRAG? : https://www.efrag.org/About/Facts
[9] Corporate Sustainability Reporting Directive: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464

Figure 2: United Nations' Sustainable Development Goals

Source: UN SDG: https://sdgs.un.org/goals

The progress towards the fulfillment of the goals is reported on an annual basis by UN and the input to them is voluntary for each actor.

3.1.6 CDP – Carbon Disclosure Project (framework)

CDP was established as the 'Carbon Disclosure Project' in 2000, asking companies to disclose their climate impact upon request of the investors, purchasers and city stakeholders. Its disclosure measures are aligned with TCFD recommendations and foster environmental transparency and accountability for tracking progress towards three key areas: a sustainable net-zero, deforestation-free and water secure future. Except for companies, states and cities have also been added in the reports resulting in the creation of a rich data hub to be used as reference.[10]

3.1.7 SBTi - Science Based Targets initiative (framework)

The SBTi is a partnership between the CDP, the United Nations Global Compact, the World Resources Institute (WRI) and the World-Wide Fund for Nature (WWF). Its goal is to provide a clearly-defined pathway for companies to reduce greenhouse gas (GHG) emissions, helping to prevent the worst impacts of climate change and future-proof business growth. Targets are considered 'science-based' if they are in line with what the latest climate science deems necessary to meet the goals of the Paris Agreement – limiting global warming to 1.5°C above pre-industrial levels. The SBTi Progress Framework11 aims to advance the work done on measurement, reporting and verification (MRV) of science-based targets, by identifying the key factors that need to be standardized to ensure consistency in the way companies measure and report progress against targets, considering decarbonization vis-a-vis other factors that lead to a change in estimated and reported emissions including structural, methodological or data variations. One

[10] CDP data and insights: https://www.cdp.net/en/data
[11] Science Based Targets resources: https://sciencebasedtargets.org/resources

differentiation point of this framework compared to the ones already mentioned is the focus on the target performance, aiming to explore the types of interventions that can enable entities to make credible decarbonization claims across different activities and emission sources.

3.1.8 GHG - Greenhouse Gas protocol (standards & tools)

GHG Protocol[12] establishes comprehensive global standardized frameworks to measure and manage GHG emissions from private and public sector operations, value chains and mitigation actions. It supplies the world's most widely used greenhouse gas accounting standards as well as a variety of tools for calculating emissions (cross-sector, country-specific, sector-specific as well as tools for countries and cities). As implied by its name if laser-focused on GHG emissions measurements as a way to describe and track progress toward climate goals.

3.1.9 CTI – Circular Transition Indicators Framework

Researching for existing resources to be leveraged for the Plooto sustainability framework, circular economy measurement frameworks are of key importance. The Circular Transition Indicator (CTI) framework[13] is measuring circularity that can be applied to businesses of all industries, sizes, value chain positions and geographies and is broadening the GHG impact calculation by adding ways to measure the impact of different recovery strategies to the GHG reductions. It also quantifies the impact of circularity on nature, where business has a critical role to play in protecting and restoring natural systems. The CTI framework was developed by the World Business Council for Sustainable Development and 30 of its members. A number of its KPIs are also incorporated as they are in the Plooto framework as well.

3.1.10 SCOR – Supply Chain Operations Reference Model

Plooto aims to create a Circular and Resilient Information System by twinning circular value chains. Understanding the processes within the supply chain is therefore fundamental for improving them and making them as well more sustainable and circular. Besides, the Supply Chain Operations Reference Model (SCOR)[14] describes the processes needed to take place in order to satisfy customer demands, by also providing a standardized baseline for improving these processes and creates a standard method for evaluating the supply chain's efficiency and effectiveness to highlight improvement areas. As a standard, companies in any industry with a supply chain use it successfully in order to ensure business viability when making any decision.

3.1.11 Doughnut Economics framework

Quite different from most of the frameworks, tools and standards mentioned so far, the Doughnut Economics framework is not inspired by the need for sustainable growth but for prosperity which may come from different routes. Think of it as a compass for human prosperity in the 21st century,

[12] GHG Protocol: https://ghgprotocol.org/about-us
[13] CTI Framework: https://ctitool.com/cti-framework-2
[14] SCOR framework: https://scor.ascm.org/processes/introduction

with the aim of meeting the needs of all people within the means of the living planet. Figure 3 visualizes the framework's basic concepts.

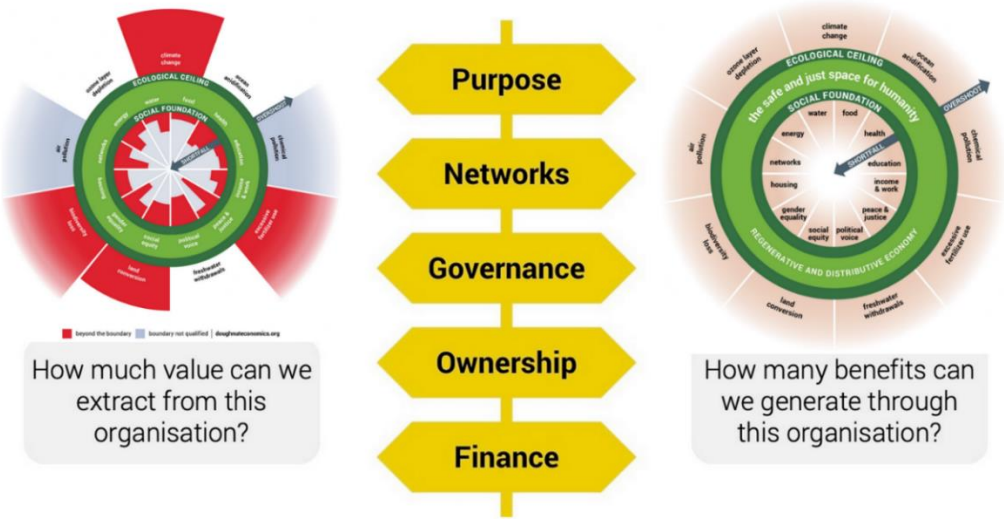

Figure 3: Doughnut Economics overview

Source: Dougnut Economics for Businesses tool: https://doughnuteconomics.org/tools/206

The Doughnut consists of two concentric rings: a social foundation, to ensure that no one is left falling short on life's essentials (clean water, food, health, education, income and work, peace and justice, political voice, social equity, gender equality, housing, networks and energy), and an ecological ceiling, to ensure that humanity does not collectively overshoot the planetary boundaries (climate change, ocean acidification, chemical pollution, excessive fertilizer use, freshwater withdrawals, land conservation, biodiversity loss, air pollution, ozone layer depletion) that protect Earth's life-supporting systems. Between these two sets of boundaries lies a doughnut-shaped space that is both ecologically safe and socially just: a space in which humanity can thrive. Until about one year ago Doughnut Economics[15] were focused on cities and states but since 2022 it has created a compass for businesses as well, identifying the key layers of a business design that can make it sustainable and regenerative: Purpose, Networks, Governance, Ownership, and Finance.

3.1.12 Sustainability Scorecard for products

This tool as well is rather different compared to the ones mentioned before since it's one that focuses on products and/or processes rather than businesses. The Sustainability Scorecard takes a different perspective on measurements by zooming in production results and comparing them before and after implementing 4 principles for Managing and Scaling Sustainability: 1. Waste prevention: measuring and comparing waste, space and process intensification metrics; 2. Maximizing efficiency and performance: evaluating material efficiency, environmental health metrics and human health metrics; 3. Renewable inputs: considering renewable carbon-free

[15] Doughnut Economics: https://doughnuteconomics.org

energy inputs, waste energy utilization and renewable feedstocks; 4. Safe degradation: tackling persistence of "forever chemicals" in final products, bioaccumulation product lifecycle duration stages in particular its induction and its disposal. It works on a complementary basis with existing business wide frameworks and serves well in innovating the way businesses produce things better [3].

3.1.13 Other resources consulted

Aiming to keep this section short, a brief paragraph is dedicated to the key resources Plooto consulted. However, there is still a number of important sources of information and knowledge contributing to devising the first version of the Plooto framework described in Section 3.4. It is worth mentioning the ISO standards and in particular the ones for Guidance on social responsibility (ISO 26000-2010) and for Environmental Management Systems (ISO 14001-2015) serve as a foundation for most businesses who desire to establish and further develop their sustainability strategy. The Ellen MacArthur Foundation's Circulytics framework offered the team information regarding a company-level measuring tool to assess circularity within any business' operations. Provided that from 2024, the EC will require businesses to adopt the European Sustainability Reporting Standards (ESRS) linked to the recommendations coming from TCFD and TNFD (Paragraph 3.1.4) extra attention was paid to these more up-to-date and in line with the Latest EU directive metrics. Last but not least the Natural Capital Coalition protocol was also a very informative reference providing a decision-making framework that enables organizations to identify, measure and value their direct and indirect impacts and dependencies on natural capital.

3.2 Necessities to tackle

Nowadays, a manager wanting to introduce a Sustainability Framework in his/her company needs to undertake a long process of selection first. In fact, the market is quite full of options for different specific types of company or organisation. However, these frameworks are often focused on the single company in question, without looking at the larger picture. Moreover, most of the frameworks need specialized consultancy and operators in order to be implemented in a company.

The research on this topic – especially considering the whole supply chain - is fragmented, and does not provide meaningful real-life applications of such solutions [12].

Plooto will create a new easy-to-use framework, manageable also by unskilled workers. This will be possible thanks to our close collaboration with the pilot cases of the project, who have been consulted on the Sustainability Balanced Scorecard Framework since the beginning of its implementation. This co-creation process was put in place specifically to make sure that the framework is usable and that it tackles directly the necessities of the end user.

The Plooto framework will be adaptable for many different types of industries and will not be a field-specific framework, in contrast with many other systems on the market. This is because most

of the previous frameworks are company/field-specific, while Plooto one will be more focused on the process and the value chain linked to it.

The famous frameworks that Plooto took as reference for its Sustainability framework – that are detailed in Section 3.3 of this document – were created many years ago. They are very complete and each one of them has its own merits regarding methodology, structure and depth of analysis. The Plooto framework got inspiration from them for their most valid contributions. However, being in the market for many years they lack a fundamental structural feature: they were not designed to be integrated in modern, complex digital systems. On the other hand, our framework is created specifically with the new technologies in mind – such as digital twins and digital product passport – and the framework is being designed specifically to fit in this new technological context. Moreover, this framework is created in order to be ingested in a SBSC perspective (the details of this process will be described in Section 4.2 of this document and, more extensively, in Deliverable D3.5 "Plooto Balanced Scorecard" due in Month 18).

On the business perspective, Plooto SBSC framework will allow stakeholders to have a wider view on their own industry - and also to expand it in the supply chain if needed. The great amount of KPIs (described in Section 4 of this document) present in this framework allow for a flexibility of the tool, that can adapt to many different business scenarios, not only the ones described in our pilot activities. The structure of the framework (Section 3.4) reflects the importance of the business perspective with a whole horizontal layer of KPIs devoted to Economy & Growth.

3.3 Relations to Tasks T1.2 and T1.3

This section will detail the work done in Task 1.2 and Task 1.3 of the Plooto project. The approach followed in Task 1.4 and the relations with the current report are detailed in Section 2 of this document.

Task 1.2 - Reference Processes and Digital Traceability Strategies

Creating sustainable value chains is a strategic imperative in industrial teams, as reported in the White Paper of Word Economic Forum. The processes of reusing, remanufacturing and recycling are among the key actions towards environmental impact minimization. Nevertheless, the path to conquer sustainability and resiliency in industrial value chains needs tangible actions and proofs of targets delivering. According to the World Economic Forum, the answer to this is the traceability across the value chain.[16]

Traceability provides to the companies the ability to identify strategic value chain opportunities, to innovate, minimize the impact of internal and external disruptions and certify sustainable processes and/or products by meeting the standards and certification requirements. Supplier sourcing practices and conversion processes are combined with the tracing of the products

[16] http://www3.weforum.org/docs/WEF_Digital_Traceability_2021.pdf

across the value chain and the provenance of inputs, aiming to actively deploy traceability and foster industries to achieve their goals[17]. Traceability has been based on the pressure to companies and government for a change, aiming to increase transparency of the product, the origin of its material, the processes followed, the environmental impact, ensuring that value chains are ethical, environmentally friendly and reliable.

Traceability Framework

According to the World Economic Forum, the Traceability Framework incorporates the desired goals of the industry, the available traceability solutions, and the key-segments that will play the role of the enablers.

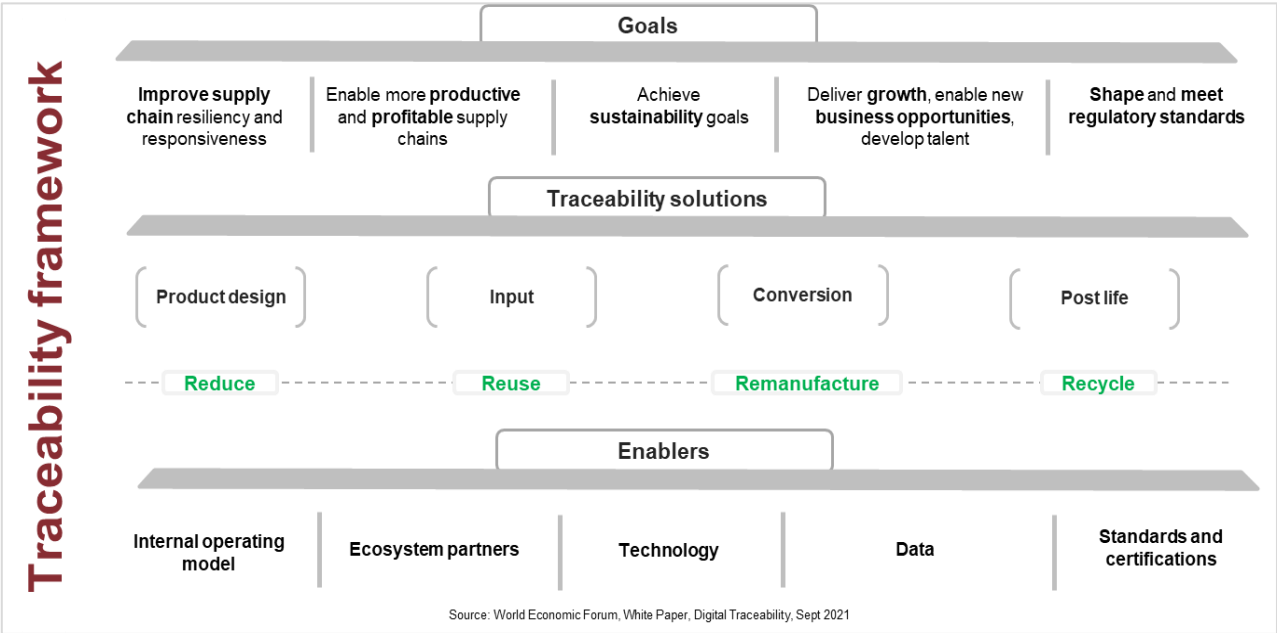

Figure 4: The Traceability Framework

Figure 4 depicts the generic traceability framework that comprised the initial step for designing the Plooto pilots' traceability strategies.

The traceability framework encloses several practices and actions that are included in four critical steps that aim to ensure success in applying the framework, as follows:

1. Connecting traceability to sustainability business objectives
2. Building a collaboration ecosystem across the value chain
3. Understanding and deploying the traceability key-enablers
4. Shifting from experimentation to transformation carrying out a rapid test-and-learn approach

Before initiating the framework's steps application, a crucial step should take place: the **assessment of maturity** of traceability programs of each investigated industrial company and

[17] http://www3.weforum.org/docs/WEF_Digital_Traceability_2021.pdf

its value chain. Following this aspect, for each of the Plooto pilot use cases, an initial assessment of the traceability strategies was carried out, exploiting the findings of T1.1, delivering the following outcomes:

- CFRP Waste for Drones: the Italian pilot in Plooto uses the uncured prepreg derived from cutting and the expired prepreg rolls as input material. Three companies are involved in this value chain 1. the HP Composites, which produces the carbon fiber products for aviation, maritime and automotive, and is responsible for storing, packaging and transportation processes, 2. the CETMA, which analyses the waste properties and is responsible for requalification process, and 3. the CC-CETMA Composites, which is responsible for the remanufacturing processes. One of the main challenges that this use case aspires to address is the lack of traceability across the value chain. To this end, the Italian pilot is placed at low-level maturity.
- WEEE for Magnets: the Spanish pilot in Plooto uses magnets, mainly extracted from washing machines as input material. Three companies are involved in this value chain 1. Ferimet, which is responsible for disassemble of machines/appliances, engines/motors and the manual magnets extraction, 2. IMDEA, which is responsible for sorting, demagnetisation, uncoating (only to Sr-ferrite magnets), crushing, and mixing of the bonded magnets, and 3. IMA, which is responsible for mixing ferrite and NdFeB- and sintered ferrite magnets, the injection, the magnetisation and the quality control, packing and storing. Generally, this pilot focuses on refining the overall process, especially with regards to Ferimet's operational procedures. Some initial actions/ideas have been identified to optimise production, nevertheless, a traceability strategy does not exist, therefore, the Spanish pilot is placed at low-level maturity.
- Citrus Processing Waste for Juice By-products: the Greek pilot in Plooto produces orange juices and uses the citrus waste to produce cattle feeds and orange oil. ASPIS is the company that is involved in this value chain, and is responsible for the juice production, the CPW transformation processes for cattle feed industry (milling, neutralization, dewatering), the citrus peel wastewater processes (extraction and centrifuge), the orange oil extraction, the sludge management processes (refining, desludging), and the processes for water, d-limonene and molasses (condensation, decanter, cooling, mixing and storing). ASPIS aims to refine the transformation processes of by-products to produce cattle feeds and to investigate new business opportunities, but still, no traceability strategy has been defined. Therefore, the Greek pilot is placed at low-level maturity.

Considering the objectives and goals that each pilot case aspires to achieve through Plooto project, the level of complexity of the involved value chains, and the current situation in digital traceability approaches, the Plooto use cases present a great potential for implementing and delivering efficient and viable digital traceability strategies.

To this end, the outcomes of the assessment were compiled with the traceability framework steps for creating a traceability-specific flowchart of questions, to serve as the initial action for identifying the critical points and approaches throughout the traceability implementation procedure.

Figure 5: Traceability Process in Plooto Use Cases

Starting from the identification of the critical points across the value chain that will create the greatest value for the industry, going beyond to defining the objectives that will underline the strategy, to the Proof of Value practices and application, until to reach the final stage, where the capability becomes a standard for the industry. These questions/stages were incorporated into the steps of traceability framework.

Connecting traceability to sustainability business objectives

The principal business objectives for supply chain management are *reliability* and *efficiency*. In Plooto project, the pilot cases confirmed that efficiency is one of their main objectives, and according to the value chain involved, the indicated the desired objectives towards circularity, including new business opportunities, external best practices collection and optimal combination of recycling and remanufacturing techniques (CFRP waste for drones). Improved technologies for dismantling and disassembling, optimization of full process ferrite and production of magnets easily recycled are included into the WEEE for magnets main objectives, while for the last pilot, the citrus processing waste for juice by-products, the objectives lied to optimized processes for achieving efficiency, new business opportunities out scaling the current activities and implementing sustainable and circular strategies and engage new customers.

Therefore, the main business objectives in Plooto industrial companies and their value chains, were *sustainability*, *resiliency*, *efficiency*, *new business opportunities* and *new customers engagement*.

Building a collaboration ecosystem across the value chain

Successful traceability efforts require collaboration for strengthening the competitive advantage of individual companies. The exchange of essential information and practices among collaborative companies can build a concrete value-creation model, but it can also build trust among companies, which will be empowered through the traceability solutions and the common efforts among the collaborative parts.

The case of Plooto project has conquer the collaboration stage, since two of the three pilots involve complex value chains with more than one company implicated in the investigated value chains: the CFRP Waste for Drones and the WEEE for Magnets. In CFRP Waste for drones, HP

Composites is the industry providing carbon fiber products, responsible for storing, packaging and transportation procedures. CETMA and CC are the next link in the chain, involving with the transformation processes, and ACCELI is the end-user/company that exploits CFRP for drones manufacturing. In WEEE for Magnets case, Ferimet is the industry providing the "input" in this value chain, responsible for the disassemble of WEEE products and magnets extraction. The value chain is completed with IMA and IMDEA, responsible for the transformation processes, compiling therefore, a complex value chain. In the case of Citrus Processing Waste for Juice By-products, the producer company is the only one involved, however, as it derives from the T1.1 and the Circular Value Chain Framework, ASPIS intends to investigate extended collaborations with other companies such as the orange-feedstock companies, by producing fertilizers and compost to provide those products back to them. Nevertheless, more collaborations can be investigated though the traceability strategies with regards all the three pilot value chains and the involved companies.

Understanding and deploying the traceability key-enablers

According to the White Paper of the World Economic Forum, there are four traceability enablers identified across a value chain: *data and technology, company operating model, collaboration and partnerships,* and *standards and certifications*[18].

The company operational model, despite that in principle tends to undercut traceability, provides data-driven evaluation of trade-offs, creating a direct connection with data and technology. Data is exceptionally important for structuring robust collaborations by exchange of information among the collaborative parties. Collaborations can achieve reduced transaction costs in applying standards and obtain certifications, which in turn provide verifiable products/materials. This closed loop among the traceability enablers brings in the frontline the incentives that are necessary for developing a successful traceability strategy.

In Plooto pilot cases, the operational models of each value chain have been identified, and potential collaborations outside of the value chain have been discussed and noticed, as presented above and derived from the D1.1. The data exchange includes the combination of data provision with other applications such as advanced analytics, prediction modeling, decision-making support and automated data exchange. Within Plooto, the data mapping has been completed within the context and activities of WP2, for delivering the modelling and operation applications, including analysis of value chains processes, the interrelations among different companies, where applied, and the final products/material/outcomes. Plooto project incorporates critical technology building blocks such as the Waste Supply Chain Data Space (Task 2.2), Predictive Analytics and AI (Task 2.4), Prescriptive Analytics and Optimization (Task 2.5), and Process Modelling and Simulation (Task 2.6).

[18] http://www3.weforum.org/docs/WEF_Digital_Traceability_2021.pdf

Shifting from experimentation to transformation carrying out a rapid test-and-learn approach

The last step of traceability framework empowers the transition from the framework application towards the real implementation of demonstrating the value of tracing, enclosing the three above-mentioned steps.

Waste Deposit Reference Processes

Reference processes in industrial value chains are designed processes that capture and maintain a set of best practices to the industrial domain.[19] The product design and development, the supply chain, the manufacturing procedures, the practices of quality management, the logistics and distribution, the marketing and sales, the customer service and support, the research and development (R&D), the training of employees and human resources, are among the generic categories of reference processes for the industrial sector.

More specifically, the waste deposit reference processes that take place in Plooto pilot use cases, include the discarding, recycling, reusing, waste controlling (Magnets, Juices/Citrus, CFRP Drones), remanufacturing (CFRP Drones), refining (Juices/Citrus).

Digital Traceability Strategies

Traceability strategies in Plooto project provide the opportunity to stakeholders for fostering innovation, minimize the impact of internal and external disruptions with regard to the company, and certifying sustainable processes and products.

The traceability strategy aims to track and trace products for ensuring their sustainability and quality, and assessing the environmental impact, identifying in parallel the economic and business opportunities, engaging customers and enabling collaborations. To this end, the traceability strategies enclose the "re-processes", a dedicated group of processes in enhancing circularity and sustainability across the value chain: **reduce** the use of virgin raw materials, **reuse** of materials/products, **remanufacture** of recycled materials that re-enter the supply chain, and **recycle** materials/products and/or waste, to re-enter the industrial processes as feedstock. Moreover, the pilots of Plooto project will investigate the collaborations with other companies, stakeholders, customers and suppliers, will exploit the technologies to deploy the traceability across the value chain (Data Space, Predictive Analytics, AI, Prescriptive Analytics, Optimization, Process Modelling, Simulation), in combination with the data monitoring and exchanging. Certifications and standards will be part of the regulatory compliance, together with products' quality assurance.

[19] https://www.sciencedirect.com/topics/computer-science/reference-process

Task 1.3 - Information Modelling Framework

T1.3 will create the required semantic framework for supporting all of the circular value chain typologies and scenarios based on the information collected from T1.1 and T1.2 and also the pilots. Task 1.3's output will serve as an interoperability enabler for the functional and business components of Plooto integration. The construction of Knowledge Graphs will be facilitated by both top-level and domain-specific ontologies (based on Industry commons), which will also aid in the development of analytical, optimisation, simulation, monitoring, and decision support tools. Semantic framework lifecycle features like scalability, maintainability, and adaptability will be guaranteed at every turn.

Specifically, the contribution of T1.3 and the developed models will be help on delivering the right information to the Plooto platform in order to calculate the different indices such as the sustainability scorecard. Furthermore, based also with the requirements for the calculation of the sustainability scorecard the different models will be enriched in order to assure that they cover the required information. Below it is presented a draft version of the function aspect for the IMA node of the Spanish pilot. Each of the boxes represent a function which each function will have several attributes, those attributes will be the requirements for each of the Plooto components, such as the sustainability scorecard.

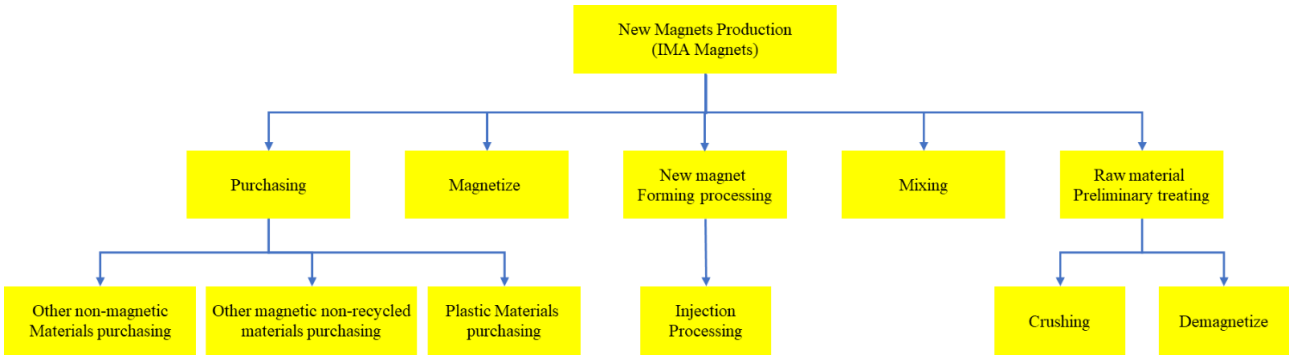

Figure 6: Draft Function Aspect for the IMA node in Spanish pilot case

3.4 Structure of the Plooto Sustainability Framework

The Plooto Sustainability Framework integrates different concepts and KPIs present in the various Reference Frameworks, detailed in Section 3.1, in order to obtain a more up-to-date and more complete system. In general, the goal of the ESG framework is to capture all the non-financial risks and opportunities that are essential to the daily activities of a company. Therefore, ESG framework focuses on environment, society and governance, excluding the financial and growth perspectives.

Nevertheless, Plooto project aspires to have a positive and measurable impact on value chains circularity, sustainability, and resiliency. To be aligned with these objectives, requires the integration of financial aspect into the **Plooto Integrated Framework**, which has been based on two *main pillars*, a. the **Sustainability Framework**, which includes the ESG plus financial & growth perspectives, and b. the **Governance Framework**.

To these selected KPIs will be added new ones as will be described in detail in Section 4. Moreover, the pilot partners contributed to the definition of the framework and gave suggestions allowing for the system not only to enhance its flexibility, but also to better adapt to their specific process and product domain. The Plooto Sustainability framework is represented here below:

Figure 7: Plooto Sustainability Framework structure

The structure clearly echoes the one from the ESG framework, with the same division of the KPIs between Environmental, Social and Governance KPIs. This is intended to ensure more clarity in the KPIs definition and management. The same is true for the subdivisions in clusters of KPIs such as "Carbon footprint" or "Resources". The horizontal layer of Economy & Growth was integrated in the structure in order to give a better business perspective, that will possibly also include the whole supply chain of the interested stakeholder. More importance has been given to this point of view adding also the "Opportunity" driven KPIs in each vertical domain [15].

The number of indicators present in the framework is large and the pilot partners have been encouraged to add new KPIs that are relevant to their industrial domain, throughout the supply chain. This large number of indicators wants to ensure a great flexibility for the end user, that will then select and study the KPIs more suitable for its specific case. The growing number of indicators could have brought to a lack of clarity in the framework. However, thanks to the division in clusters, the framework remains easy-to-navigate also with high numbers of criteria.

The different Key Performance Indicators present in the Plooto Sustainability Framework will be described in detail in Section 4 of this document.

4 Key Performance Indicators

Key Performance Indicators (KPIs) play a critical role in Plooto, especially in developing and delivering the Sustainability Balanced Scorecards (D3.5) and connecting the pertinent inter-relations among the waste treatment operations and waste value chains.

The European Round Table (ERT) for Industry has declared since 2021 that decision-makers call for data-driven evidence to initiate the implementation of suitable policies and strategies, aiming at measuring, among others, industrial performance, through quantifiable targets derived from concise sets of KPIs.[20] This concise list of KPIs is used to measure the success level in delivering industrial competitiveness, one of the main targets during Europe's Digital Decade.[21]

Despite the robust-structured approach of ERT for activating the EU Industrial Strategy[22], Plooto foresees to adopt a comprehensive methodology in setting KPIs, following the approach of the Governance Framework and Sustainability Framework that presented in Section 2.3, aspiring to shape an integrated framework for the Plooto Sustainability Balanced Scorecard (SBSC). The SBSC will serve as a performance assessment, aiming to cover all the four pillars (environment, society, governance, economy & growth) by structuring an all-inclusive list of indicators.

Main objective of this list is to be capable of easily adaptation and expansion by every industrial value chain, following a cause-and-effect model and empowering the replicability and scalability potential of Plooto project.

4.1 Methodology for KPIs identification

Plooto's integrated approach aims to structure a comprehensive framework that ensure sustainability, circularity and growth of industrial, among others, supply chains. This integrated framework showed the path for developing a two-fold KPIs catalogue: a generic list of KPIs, adjustable and flexible to be integrated into every industrial supply chain, and the three tailored Plooto cases' KPIs lists, each one including the suitable indicators selected from the generic list, accompanied with the specific KPIs indicated in the DoA.

The generic list of KPIs was structured following the Plooto Sustainability Framework, delivering, therefore, indicators from four main pillars/categories: **environment, society, governance** and **economy and growth.** Moreover, extended research was conducted in available literature, targeting to identify and enclose representative indicators that will sufficiently depict the improvements and goals of the pilot use cases in terms of sustainability and circularity of supply chains.

[20] ERT, Digital Transformation, May 2021 - https://ert.eu/wp-content/uploads/2021/05/ERT-DigitalTransformation-Paper-May-2021_final-1.pdf

[21] Europe Digital Decade, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en

[22] ERT, Putting the EU Industrial Strategy into action, https://ert.eu/wp-content/uploads/2020/11/ERT-Publication-Putting-the-EU-Industrial-Strategy-into-action_Nov-2020.pdf

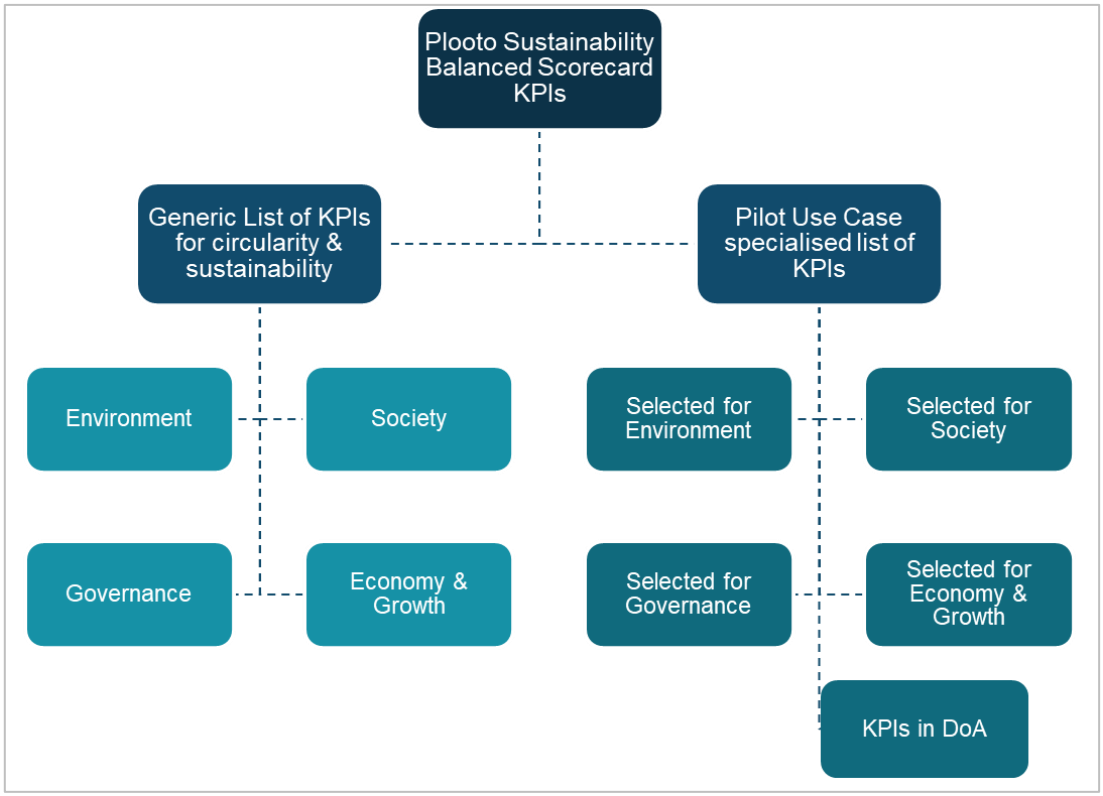

Figure 8: Plooto Sustainability & Governance Framework KPIs

The KPIs identification was based on the Plooto Sustainability and Governance Framework, which structure an integrated approach, the Sustainability Balanced Scorecard Framework, to be the core element for developing the Sustainability Balanced Scorecard within WP3. This framework targets to be adaptable and scalable from all value chains in industrial sector that aspire to be sustainable, resilience and circular, gain economic advantage and achieve transparency and promote traceability practices.

The extended KPIs list was a consequence of the comprehensive character of the framework. During the implementation phase and for delivering the final iteration of the Balanced Scorecard Framework through the D1.4, some adjustments may occur, according to the pilot's use case technical requirements.

4.2 Cause-and-effect Model and Scalability

Cause-and-effect analysis is used to identify the core possible causes that can influence an event. To represent this systemic relation of core causes and the investigated event, Kaoru Ishikawa developed the CE (cause-and-effect) diagram, by examining a specific topic (driving time) and the major causes that can influence and trigger this event (traffic, vehicle, speed limit, distractions).[23]

[23] https://www.sciencedirect.com/topics/engineering/effect-diagram

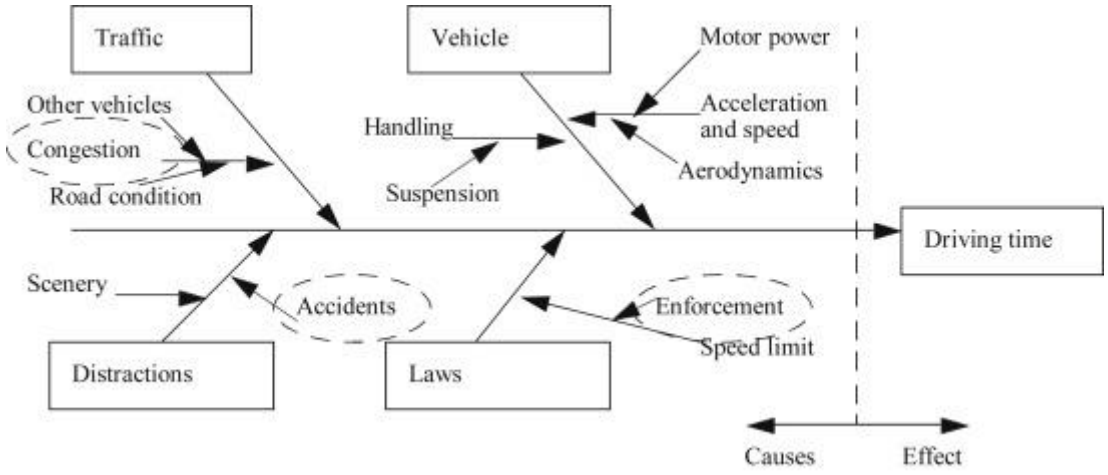

Figure 9: Example of a cause-and-effect diagram

Note: When constructing the diagram, consider factors that both reduce and increase the effect. Any cause can be subdivided into finer factors. Source: https://www.sciencedirect.com/topics/engineering/effect-diagram

The cause-and-effect analysis can contribute to the identification of all likely causes of a problem or difficulty or situation, providing the opportunity to target, focus, face and address effectively this situation and consequently, to solve the problem or address the difficulty or improve the situation.

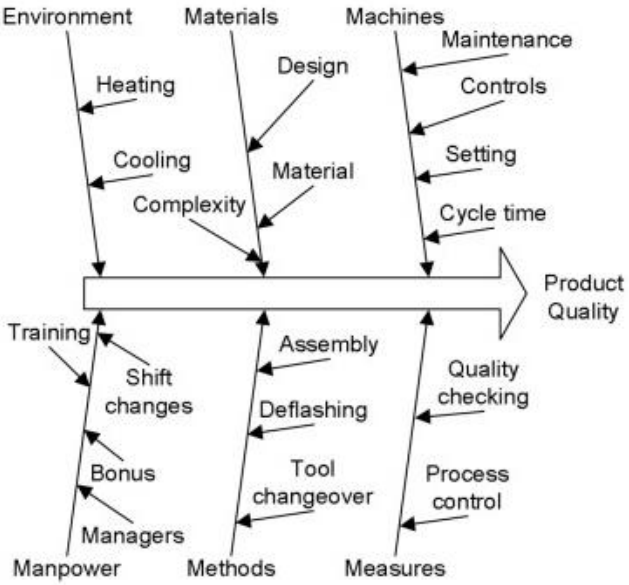

Figure 10: Example of cause-and-effect chart for production

Source: https://www.sciencedirect.com/topics/engineering/effect-diagram

In Plooto, the cause-and-effect model was followed in the identification of the KPIs that come along with and support the Sustainability & Governance Framework. Through the framework for Circular Value Chains that has been developed and reported in D1.1, and the corresponding activities (interviews, questionnaire, business canvas, etc.) several critical outcomes derived,

including the information regarding the relationships among pilot's participants to draft governance strategies and to identify the relevant KPIs to assess the value chain performance. As reported in D1.1, circular value chains support critical sustainability and economic requirements for creating closed-loops systems, including *natural resources and raw material conservation, waste reduction and extended lifecycle, resilience to supply chain disruptions*.

Governance models and the Sustainability Balanced Scorecard Framework have been the basis of the "closing-the-loop" industrial value chains, bringing in the frontline the circularity of value chains, which is reinforced by the traceability and transparency strategies, and reference processes, as presented in section 3. For developing and delivering viable value chains, the aspects of ***economic advantage***, ***resiliency***, ***sustainability***, ***traceability***, ***transparency*** and ***circularity*** were critical components in the Circular Value Chains Framework that derived from T1.1.

To this end, the cause-and-effect analysis in Plooto project's KPIs, focuses on the main target of creating viable value chains and transforming any industry into a green and competitive facility, identifying as essential aspects the economic advantage, resiliency, sustainability, traceability, transparency and circularity. Those features were integrated into the methodological approach of KPIs identification (presented in the previous sub-section). Thus, each one of the KPIs selected to measure and perform an assessment of the industry/company with regards to the aforementioned aspects.

4.3 Environmental KPIs

A great number of studies have been undertaken attempting to measure the environmental performance of industries deepening into their supply chains' assessment, exploiting models and frameworks such as the SCOR model [8], the ESG framework [6], practice-based theories [14] and many other methods under the Green Supply Chain Management (GSCM)[24] approach. Critical component and objective are to empower sustainability and circularity throughout the industrial supply chain, bringing therefore, in the frontline the environmental performance.

Following the Plooto Sustainability Framework, the KPIs enclosed in the environmental pillar are divided in several sub-categories, such as the *carbon footprint*, *resources*, *pollution, and waste*, *Life Cycle Assessment (LCA),* and *opportunities and innovation*.

- **Carbon Footprint:** this category includes the KPIs relevant to the measurement of greenhouse gases, enclosing the carbon dioxide (CO_2) and methane (CH_4).
- **Resources:** this category includes the indicators that represent the resources consumption across the value chain, such as the energy, the water, the fossil fuels depletion, and other.

[24] https://www.sciencedirect.com/topics/earth-and-planetary-sciences/green-supply-chain-management

- **Pollution**: the KPIs of this category referred to the different types of waste (electronic waste, scrap waste packaging materials, etc.) and the relevant indicators depicting their management (i.e., mass of reused component as feedstock to manufacture a product, etc.).
- **LCA**: the KPIs of this category are indicators used for assessing the Life Cycle of the industry, referring to them that are not included in the resources and carbon footprint categories i.e., land use.
- **Opportunities and Innovation**: this category of KPIs include indicators that assess the performance or use of Greener Technology, Greener Building Structure/Management and Sustainable Energy Source/Management.

Table 2 below presents the full list of environmental KPIs per eligibility category.

Table 2 – Environmental KPIs

KPI Name	Description	Unit	Eligible for category	Cause-and-effect
Carbon Dioxide (CO_2) [2] [10]	Amount of CO_2 released from the activities across the supply chain	kg_{eq}	Carbon footprint	Sustainability
Methane (CH_4) [16] [17]	Amount of CH_4 released from the activities across the supply chain	kg_{eq}	Carbon footprint	Sustainability
Water stress/ consumption [16] [17]	Amount of water consumed across the industrial processes	kg	Resources	Sustainability
Amount of water reused [17]	Amount of water reused across the industrial processes	kg	Resources	Sustainability, Circularity
Amount of water treated [17]	Amount of water treated before returning to the ecosystem	kg	Resources	Sustainability, Circularity
Energy consumption [16]	Amount of energy consumed across the supply chain	kWh	Resources	Sustainability
Use of RES/RES integration [1]	Amount of energy produced by RES	kWh	LCA/Resources	Sustainability, Resiliency
Fossil fuels depletion [5] [17]	Amount fossil fuels reduction (or energy from RES) in consumed energy mix	kg or kWh	LCA/Resources	Sustainability, Resiliency
Transportation processes [17]	Consumptions related to the transportation/logistics (i.e., energy)	DOC	Resources	Sustainability
Green logistics [7]	Amount of emissions during logistics activities (warehousing and transportation)	kg	Resources	Sustainability, Resiliency
Supply chain waste [12]	Amount of distributed plastics	kg	Pollution and Waste	Circularity

KPI Name	Description	Unit	Eligible for category	Cause-and-effect
Recycling rates [10]	Amount of recycled plastics	kg	Pollution and Waste	Circularity
Use of biodegradable materials	Amount of biodegradable materials produced/used	kg	Pollution and Waste	Circularity
Packaging materials and waste [1]	Amount of waste from packaging material	kg	Pollution and Waste	Sustainability
Electronic Waste [2]	Amount of electronic waste	kg	Pollution and Waste	Sustainability
Scrap Waste [2]	Amount of scrap waste	kg	Pollution and Waste	Sustainability
Resource Utilization [10]	Percentage of use of non-renewable resources across the supply chain	%	Resources	Sustainability, Resiliency, Circularity
Consumption of virgin raw materials [14]	Amount of virgin raw material consumed	kg	Resources	Sustainability, Resiliency, Circularity
ISO22400 for traditional manufacturing [16]	ISO Certification that the company/industry meets the certification standards	-	Opportunities and Innovation	Sustainability, Resiliency, Transparency
ISO59020 for measuring and assessing circularity	ISO Certification that the company/industry meets the certification standards	-	Opportunities and Innovation	Circularity

4.4 Social KPIs

Addressing the social issues in business strategies has become an essential segment towards the sustainability and circularity of any industry or company [8]. More specifically, the aspects of human rights and equity, as well as the policies and actions of an industry that has impacted the individuals, groups and society, play a significant role in its overall performance. It considers topics such as working conditions, product safety, human rights, community relations, and in supply chain transparency, which is crucial in the Plooto project and its objectives.

The social feature represents the willingness of the organisation to meet the human obligations in operations, supply chains and local societies. Representative indicators of social performance are among others the diversity, income equality, workplace injury rates, philanthropy.[25] The indicators of this pillar are mainly qualitative indicators, reflecting the performance of the industry in the local community.

Following the Plooto Sustainability Framework, the KPIs regarding social performance are divided in four sub-categories: *human capital, product assessment, stakeholders* and *opportunities.*

[25] https://www.onetrust.com/blog/esg-101-what-does-social-in-esg-mean/

- **Human Capital**: this category of KPIs includes the indicators regarding health and safety, work management, training and staff development, labor standards, inclusion, and diversity.
- **Product Assessment**: this category of KPIs includes the indicators for safety: chemical, financial product safety, product safety and quality, privacy data and security.
- **Stakeholders**: this category refers to the KPIs that are related to the external stakeholders (suppliers, other connected companies, etc.) such as the controversial sourcing and the supply chain liability.
- **Opportunities**: the KPIs of this category include the assessment to health care, the access to finance, opportunities in nutrition and health, and work-life balance.

Table 3 – Social KPIs

KPI Name	Description	Unit	Eligible for category	Cause-and-effect
Health and Safety [14]	Assessment health and safety conditions in the industrial company	Qualitative	Human Capital	Resiliency
Gender equity, inclusion, and diversity [14][2]	Assessment of gender equity issues, inclusion and diversity in the industrial company (i.e., proportion of women/ men employees)	Qualitative	Human Capital	Transparency
Training and Staff development [14]	Availability and implementation of training programs and staff development activities	Qualitative	Human Capital	Resiliency
Chemical safety [14] [2]	The industrial company meets the standards for safety from chemical materials	Qualitative	Product Assessment	Resiliency, Transparency
Product safety and quality [14] [2]	The industrial company meets the standards for product safety and quality	Qualitative	Product Assessment	Resiliency, Traceability
Privacy and data security[14] [2]	The industrial company runs in compliance with the regulations for privacy and data security	Qualitative	Product Assessment	Transparency
Transparency within the Supply Chain [10]	The level of transparency regarding the quality and origin of the materials, the processing, etc.	Qualitative	Product Assessment	Transparency
Controversial Sourcing [14]	Origin of materials or products (involvement in harmful or unethical practices)	Qualitative	Stakeholders	Transparency, Traceability
Supply Chain Liability [5]	The legal responsibility of the industrial company for	Qualitative	Stakeholders	Transparency, Traceability

KPI Name	Description	Unit	Eligible for category	Cause-and-effect
	actions or shortcomings across its supply chain			
Customer satisfaction [14]	Level of satisfaction of costumers from the product use	Qualitative	Stakeholders	Resiliency
Employee satisfaction [14]	Level of satisfaction of employees in the company	Qualitative	Human Capital	Resiliency
Access to Health Care [14] [2]	Level of access of employees to medical services, treatment, and healthcare resources	Qualitative	Opportunities	Resiliency
Access to Finance [14] [2]	Level of access to external funding (i.e., research funding programs, loans, etc.)	Qualitative	Opportunities	Economic Advantage, Sustainability
Work-Life Balance [2]	Level of balance between professional responsibilities and personal time	Qualitative	Opportunities	Resiliency

4.5 Governance KPIs

Since 2009, the European Federation of Financial Analysts Societies (EFFAS) has defined nine topical areas which apply to all sectors and industries and has specified the list in five ESG-related sectors, considering this approach as a standardised and comprehensive framework.[26] With regards to governance, the EFFAS proposed two specific categories of KPIs: the Litigation Risks and the Corruption. According to the Plooto Governance Framework (section 2), governance KPIs shall belong in categories such as the regulatory compliance, risk management, ethical business practices, board compensation, etc. representing corporate governance aspects, corporate behaviour aspects, etc.[27] To this end, the governance KPIs in Plooto are divided into the following categories:

- **Corporate Governance**: this category of KPIs includes the indicators regarding the rules and processes that a company is being directed and managed, including the structure of the company, the ownership, the advisory board, and others.
- **Corporate Behaviour**: this category of KPIs includes the indicators for ethical standards, values and social responsibility of the company to its customers, stakeholders, local society.

[26] https://ec.europa.eu/docsroom/documents/1547/attachments/1/translations/en/renditions/native
[27] https://www.sciencedirect.com/topics/computer-science/governance-framework

- **Litigation Risks and Corruption:** this category refers to the KPIs that are related to the issues that a company faces in terms of addressing and minimizing litigation risks and corruption incidents.[28]

Table 4 – Governance KPIs

KPI Name	Description	Unit	Eligible for category	Cause-and-effect
Board diversity [2]	Level of differentiation in backgrounds, skills and characteristics of an industrial company's board of directors	Qualitative	Corporate Governance	Transparency
Anti-competitive practices [2]	Number of practices that an industrial company follows to gain an advantage in the market (i.e., price fixing, bid rigging, market allocation, etc.)	Number of practices applies in a year	Corporate Behaviour	Transparency
Tax transparency [2]	Frequency of openly disclosing information of the industries about tax payments and strategies	Number of sharing information in a year	Corporate Behaviour	Transparency
Business ethics [2]	Number of practices for ensuring ethical principles i.e., environmental responsibility, product quality and safety	Number of practices applied in a year	Corporate Behaviour	Transparency
Expenses and fines on litigation incidents [29]	Expenses and fines on filings, lawsuits related to anti-competitive behavior, anti-trust and monopoly practices	€	Litigation Risks and Corruption	Transparency
Litigation risks payments[30]	Payments for addressing litigation incidents	€	Litigation Risks and Corruption	Transparency
Percentage of revenues in regions with TI corruption[30, 31]	Percentage of revenues in regions with TI corruption below 0.6	%	Litigation Risks and Corruption	Transparency

4.6 Economy and Growth KPIs

Economy and Growth have been one of the main segments in every business prosperity plan, therefore has been considered as a critical one within the Plooto Sustainability Framework, also

[28] https://www.transparency.org/en/cpi/2022
[29] EFFAS, KPIs for ESG, European Federation of Financial Analysts Societies, Version 1.2, DVFA, 2009
[30] Science Based Targets resources: https://sciencebasedtargets.org/resources
[31] Transparency International, Corruption Indexes, available at: https://www.transparency.org/en/cpi/2022/index/ita

allowing the aspects and characteristics of the frameworks analysis and identification presentd in Section 3.1.

The Economy and Growth pillar encloses the categories of *financial, customer* and *growth perspective.*

- **Financial**: this category includes KPIs related to the economic performance of the company, such as the market share, the revenue growth, also more circularity-specific indicators such as the net cost savings due to circular activities,
- **Customer**: this category includes KPIs related to the customers' contribution into the economic performance of the industry, such as the customer retention, customer profitability, and other.
- **Growth perspective**: the KPIs of this category target to depict the growth potential of the industry, including indicators such as the revenue growth, employee retention, the employee productivity, and other.

Table 5 – Economy and Growth KPIs

KPI Name	Description	Unit	Eligible for category	Cause-and-effect
Market share [3]	The percentage of sales of a product related to all sales of that product for a specific time period i.e., per month, and for a specific geographic area (i.e., at national level)	Depends on the case/ available data, usually in € per specific month, per specific area	Finance	Economic advantage
Asset utilization[29]	How effectively uses a company its own assets to generate revenue	Qualitative	Finance	Economic advantage, Resiliency
Net cost savings due to circular activities	Assessment of savings that coming from circular activities (i.e., re-use of materials or secondary raw materials, treatment of water to enter the process, etc.)	€	Finance	Economic advantage, Circularity
Customer acquisition [3]	Number of new incoming customers per year	No	Customer	Economic advantage
Customer retention[32]	Perception of customers remaining or leaving, per year or specific period	% (±)	Customer	Resiliency
Customer profitability[29]	Assessment of net profit generated by individual customers	€	Customer	Economic advantage

[32] https://ec.europa.eu/docsroom/documents/1547/attachments/1/translations/en/renditions/native

KPI Name	Description	Unit	Eligible for category	Cause-and-effect
Employee retention[29]	Perception of employees remaining or leaving, per year or specific period	% (±)	Growth perspective	Resiliency
Productivity growth[29]	Percentage of increase in output/value generated per unit, for a specific time period	%	Growth perspective	Economic advantage, Resiliency
Revenue growth[29]	Percentage of increase in revenues/sales generating income, for a specific time period	%	Growth perspective	Economic advantage
Compound Annual Growth Rate (CAGR)[33]	Annual growth rate of an investment over a specific period of time, longer that 1 year[34]	%	Growth perspective	Economic advantage, Resiliency

4.7 KPIs per Pilot Use Case

In section 4.6, a generic list of KPIs was presented, including indicator lists that are capable of being adapted, expanded, readjusted, and applied to a wide variety of industrial companies, including the ones serving as pilot use cases in the Plooto project. Those generic indicators could be measured or assessed for presenting the overall performance of the Plooto pilots in terms of environment, society, governance and economy and growth, following the sustainability framework developed and presented in section 3.

Nevertheless, the comprehensive list of KPIs of the Plooto project is necessary to include the KPIs that is contractual obligation to be measured, also the key points defined in Task 1.1 and presented in D1.1, following the cause-and-effect approach.

Therefore, the following tables include both the KPIs per pilot use case and the main outcomes of Task 1.1, demonstrating the current value (baseline) and the outcome achieved through the Plooto's contribution (ex-post).

Table 6 – KPIs for *CFRP Waste for Drones*

KPIs and Description	Baseline	Ex-post
Prepreg shelf life	6 months	12 months
Prepreg disposal in HP	30 tons/year	10 tons/year
Value of uncured prepreg scraps for HP	-300€/tons	+300€/tons
New Jobs in partners facilities related to exploiting uncured prepreg scraps	0	5

[33] https://www.investopedia.com/terms/c/cagr.asp
[34] CAGR is measure by the formula CAGR=((Ending value/Starting Value)^(1/Number of years)-1)*100

Unused CFRP waste in the production of composite materials (%)	Not currently measured	At least 20% reduction of the existing unused CFRP waste
KPIs identified from interviews within Task 1.1 (output of D1.1)		
Reduce of the existing unused CFRP waste	-	-

Table 7 – KPIs for *WEEE for Magnets*

KPIs and Description	Baseline	Ex-post
Reduction of WEEE landfilled (for the bonded materials' part)	24,8 tn/year	16,12 tn/year
Usage of SRM (bonded NdFeb, Sr-Ferrite) in PM magnet pellets' production (%)	Not currently measured*	At least 30% increase
Number of types of validated materials	0	3
Recycling from leftovers and disregarded magnets (%)	60%	At least 75%
KPIs identified from interviews within Task 1.1 (output of D1.1)		
Improve the quantity of leftovers and disregarded magnets entered into the transformation process	-	-
Increase the usage of SRM (bonded NdFeb and Sr-ferrite) in PM magnets pellets' production	-	-
Increase the usage of Sr-ferrite crushed pellets in magnets production	-	-
KPIs from internal technical meetings for defining KPIs list		
Minimisation of raw materials insertion	-	-

**Specific measurement will take place to define the baseline value at the first year of the project.*

Table 8 – KPIs for *Citrus Processing Waste for Juice By-products*

KPIs and Description	Baseline	Ex-post
Production of animal feed	10.000-15.000 tn	At least 20.000 tn after project lifetime
Production of high-quality molasses	2.000-2.500 tn	3000-3500 tn after project lifetime
Production of d-Limonene	0.5-1.5 tn	At least 2 tn within project lifetime
Volume of CPWW (Citrus Peels Wastewater)	150.000-250.000tn	At least 10% decrease
COD of CPWW	10000	At most 2000
Volume of CPWW that goes to biological treatment	100% (after 1+ cycles)	At least 40% decrease

Revenues from animal feed	1 M	2 M
KPIs identified from interviews within Task 1.1 (output of D1.1)		
Improve energy savings	-	-
Improve cost savings	-	-

Conclusions

The activities carried out in WP1, and especially in Tasks 1.2, 1.3 and 1.4, lead partners to the definition of a first version of the Plooto SBSC Framework.

The information collected - in the form of necessities to tackle and established frameworks to use as references – gave a specific direction to the Plooto framework, which has been also validated by the use cases of the project. From the high-level framework, specific KPIs were identified that will tackle concrete issues in the different industrial domains of the use case partners. A comprehensive list of KPIs has been defined, from which every pilot case will be able to freely choose the ones that are more suitable to its specific industry/domain/supply chain necessities.

This is the first version of the Plooto SBSC Framework, that will be updated and expanded in deliverable D1.4 “Sustainability balanced scorecard framework v2”, due in Month 24.

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Appendix A: Sustainability Standards Analysis

Name	Type	Focus	*Features*
		Reporting Standards	
SASB – Sustainability Accounting Standards Board[35]	Standards	Sustainability Accounting, Environmental, Social and Corporate governance	Industry-specific disclosure standards across ESG Topics, available for 77 industry types
CDBS – Climate Disclosure Standards Board[36]	Standards	Climate and natural capital reporting towards sustainable financing	Compliance with EU policies – Corporate Sustainability Reporting Directive (CSDR), SDG 13, 15, 17, supports 12
IFRS – International Financial Reporting Standards Foundation[37]	Standards	Development and promotion of accounting standards	International Sustainability Standards Board for sustainability-related standards (IFRS-S)
PCAF – Partnership for Carbon Accounting Financials[38]	Standards	Facilitating financial industry alignment with the Paris Climate Agreement	Industry-led initiative to enable financial institutions to consistently measure and disclose the GHG emissions financed by their loans and investments
ISO Standards – International Organisation for Standardisation[39]	Standards	Helping to meet the UN Sustainable Development Goals	ISO 26000:2010 - Guidance on social responsibility ISO 14001:2015 Environmental management systems
		Reporting Frameworks	
GRI – Global Reporting Initiative[40]	Framework	Understand and communicate the impacts on issues such as climate change, human rights, and corruption	Provides the world's most widely used sustainability reporting standards

[35] https://sasb.org/standards/download/
[36] https://www.cdsb.net/sites/default/files/cdsb_framework_2022.pdf
[37] https://www.ifrs.org/projects/work-plan/general-sustainability-related-disclosures/#published-documents
[38] https://carbonaccountingfinancials.com/en/standard#the-global-ghg-accounting-and-reporting-standard-for-the-financial-industry
[39] https://www.iso.org/developing-sustainably.html
[40] https://www.globalreporting.org/how-to-use-the-gri-standards/gri-standards-english-language/

Name	Type	Focus	*Features*
CDP – Carbon Disclosure Project[41]	Framework	Investors, companies, cities and governments in building a sustainable economy by measuring and acting on environmental impact	New five-year strategy: Accelerating the Rate of Change was launched 2021
TCFD – Task Force on Climate Related Financial Disclosures[42]	Framework	Risks mitigation of climate change and advancing transparency in companies	Committed to market transparency. Climate-related financial disclosure recommendations
Equator Principles[43]	Framework	A financial industry benchmark for determining, assessing and managing environmental and social risk in projects	Common baseline and risk management framework for financial institutions to identify, assess and manage environmental and social risks
Science Based Targets[44]	Framework	Science-based targets provide companies with a clearly-defined path to reduce emissions in line with the Paris Agreement goals – commit, develop, submit, communicate, disclosure	Targets are considered 'science-based' if they are in line with what the latest climate science deems necessary to meet the goals of the Paris Agreement
Natural Capital Coalition[45]	Framework	By 2030 the majority of businesses, financial institutions and governments will include the value of all capitals in their decision-making	Global multi-stakeholder collaboration that brings together leading global initiatives and organizations to harmonize approaches to natural capital
Greenhouse Gas Protocol[46]	Framework	Greenhouse Gas Protocol provides standards, guidance, tools and training for business and government to measure and manage climate-warming emissions	Calculation tools and guidance https://ghgprotocol.org/calculation-tools-and-guidance

[41] https://www.cdp.net/en/supply-chain
[42] https://www.fsb-tcfd.org/recommendations/
[43] https://equator-principles.com/about-the-equator-principles/#EquatorPrinciples
[44] https://sciencebasedtargets.org/step-by-step-process
[45] https://capitalscoalition.org/capitals-approach/
[46] https://ghgprotocol.org/standards

Name	Type	Focus	*Features*
IR – Integrated Reporting[47]	Framework	Integrated Reporting Framework is used to improve quality of information, promote a more cohesive and efficient approach, enhance accountability, support integrated thinking, decision-making and actions for value creation	The Integrated Reporting Framework and Integrated Thinking Principles are maintained under the auspices of the IFRS Foundation
Sustainable Development Goals[48]	Framework	Indicators and a Monitoring Framework for the Sustainable Development Goals	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

[47] https://www.integratedreporting.org/resource/international-ir-framework/
[48] https://sdgs.un.org/goals